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Contribution from the Bureau of Entomology, L. O. Howard, Chief.

THE TRUE CLOTHES MOTHS.[1]

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Entomologist and Acting Chief in Absence of Chief.

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INTRODUCTION.

The destructive work of the larvæ of the small moths commonly known as clothes moths, and also as carpet moths, fur moths, etc., in woolen fabrics, fur, and similar material during the warm months of summer in the North, and at any season in the South, is an altogether too common experience. The preference they so often show for woolen or fur garments gives these insects a much more general interest than is perhaps true of any other household pest.

The little yellowish or buff-colored moths sometimes seen flitting about rooms, attracted to lamps at night, or dislodged from infested garments or portieres, are themselves harmless enough, and in fact their mouth parts are rudimentary, and no food whatever is taken in the winged state. The destruction occasioned by these pests is,

[1] A reprint, with slight revision, of Circular No. 36, Bureau of Entomology, U. S. Dept. of Agriculture.

NOTE.—This bulletin is of interest to housekeepers and those who have anything to do with fur and wool, in either the raw or the manufactured state.

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therefore, limited entirely to the feeding or larval stage. The killing of the moths by the aggrieved housekeeper, while usually based on the wrong inference that they are actually engaged in eating her woolens, is, nevertheless, a most valuable proceeding, because it checks in so much the multiplication of the species, which is the sole duty of the adult insect.

The clothes moths all belong to the group of minute Lepidoptera known as Tineina, the old Latin name for cloth worms of all sorts, and are characterized by very narrow wings fringed with long hairs. The common species of clothes moths have been associated with man from the earliest times and are thoroughly cosmopolitan. They are all probably of Old World origin, none of them being indigenous to the United States. That they were well known to the ancients is shown by Job's reference to "a garment that is moth eaten," and Pliny has given such an accurate description of one of them as to lead to the easy identification of the species. That they were early introduced into the United States is shown by Pehr Kalm, a Swedish scientist, who took a keen interest in house pests. He reported these tineids to be abundant in 1748 in Philadelphia, then a straggling village, and says that clothes, worsted gloves, and other woolen stuffs hung up all summer were often eaten through and through by the worms, and furs were so ruined that the hair would come off in handfuls.

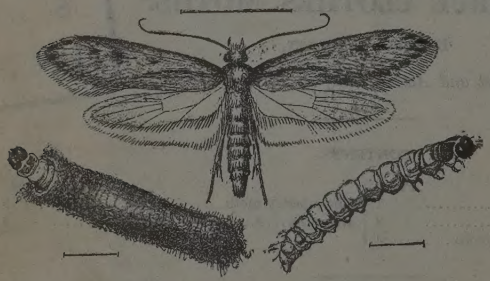

FIG. 1.—*Tinea pellionella:* Above, adult; at right, larva; at left, larva in case. Enlarged. (From Riley.)

What first led to the association of these and other household pests with man is an interesting problem. In the case of the clothes moths, the larvæ of all of which can, in case of necessity, still subsist on almost any dry animal matter, their early association with man was probably in the rôle of scavengers, and in prehistoric times they probably fed on waste animal material about human habitations and on fur garments. The fondness they exhibit nowadays for tailor-made suits and other expensive products of the loom is simply an illustration of their ability to keep pace with man in his development in the matter of clothing from the skin garments of savagery to the artistic products of the modern tailor and dressmaker.

Three common destructive species of clothes moths occur in this country. Much confusion, however, exists in all the early writings on these insects, all three species being inextricably mixed in the

descriptions and accounts of habits. Collections of these moths were submitted some years ago by Profs. Fernald and Riley to Lord Walsingham, of Merton Hall, England, the world's authority on tineids, and from the latter's careful diagnosis it is now possible to separate and recognize the different species easily.

The common injurious clothes moths are the case-making species,[1] the webbing species or southern clothes moth,[2] and the gallery species or tapestry moth.[3]

A few other species, which normally infest animal products, may occasionally also injure woolens, but are not of sufficient importance to be noted here.

THE CASE-MAKING CLOTHES MOTH.

The case-making clothes moth [1] (fig. 1) is the only species which constructs for its protection a true transportable case. It was characterized by Linnæus, and carefully studied by Réaumur, early in the last century. Its more interesting habits have caused it to be often a subject of investigation, and its life history will serve to illustrate the habits of all the clothes moths.

The moth expands about half an inch, or from 10 to 14 millimeters. Its head and forewings are grayish yellow, with indistinct fuscous spots on the middle of the wings. The hind wings are white or grayish and silky. It is the common species in the North, being widely distributed and very destructive. Its larva feeds on woolens, carpets, etc., and is especially destructive to furs and feathers. In the North it has but one generation annually, the moths appearing from June to August, and, on the authority of Prof. Fernald, even in rooms kept uniformly heated night and day it never occurs in the larval state in winter. In the South, however, it appears from January to October, and has two or even more broods annually.

The larva is a dull white caterpillar, with the head and the upper part of the next segment light brown, and is never seen free from its movable case or jacket, the construction of which is its first task. If it be necessary for it to change its position, the head and first segment are thrust out of the case, leaving the thoracic legs free, with which it crawls, dragging its case after it, to any suitable situation. With the growth of the larva it becomes necessary from time to time to enlarge the case both in length and circumference, and this is accomplished in a very interesting way. Without leaving its case the larva makes a slit halfway down one side and inserts a triangular gore of new material. A similar insertion is made on the opposite side, and the larva reverses itself without leaving the case and makes corresponding slits and additions in the other half. The case is lengthened by successive

[1] *Tinea pellionella* L. [2] *Tineola biselliella* Hummel. [3] *Trichophaga tapetzella* L.

additions to either end. Exteriorly the case appears to be a matted mass of small particles of wool; interiorly it is lined with soft whitish silk. By transferring the larva from time to time to fabrics of different colors the case may be made to assume as varied a pattern as the experimenter desires, and will illustrate, in its coloring, the peculiar method of making the enlargements and additions described.

On reaching full growth the larva attaches its case by silken threads to the garment or other material upon which it has been feeding, or sometimes carries it long distances. In one instance numbers of them were noticed to have scaled a 15-foot wall to attach their cases in an angle of the cornice of the ceiling. It undergoes its transformations to the chrysalis within the larval case, and under normal conditions the moth emerges three weeks later, the chrysalis having previously worked partly out of the larval case to facilitate the escape of the moth. The latter has an irregular flight and can also run rapidly. It has a distinct aversion to light, and usually conceals itself promptly in garments or crevices whenever it is frightened from its resting place. The moths are comparatively short-lived, not long surviving the deposition of their eggs for a new generation of destructive larvæ. The eggs are minute, not easily visible to the naked eye, and are commonly placed directly on the material which is to furnish the larvæ with food. In some cases they may be deposited in the crevices of trunks or boxes, the newly hatched larvæ entering through these crevices.

In working in feathers this insect occasionally causes a felting very similar to that produced by the black carpet beetle, *Attagenus piceus* Oliv.

The protection afforded by the seclusion of this insect in houses does not prevent its having insect enemies, and at least two hymenopterous parasites have been reared in this country from its larval cases. These are *Exochus ovatus* Davis and *Apanteles carpatus* Say, both reared from specimens collected in Michigan.

THE WEBBING, OR SOUTHERN CLOTHES MOTH.

The webbing, or Southern clothes moth [1] (fig. 2) is the more abundant and injurious species in the latitude of Washington and southward. It occurs also farther north, though in somewhat less numbers than the preceding species. It presents two broods annually even in the Northern States, the first appearing in June from eggs deposited in May, and the second in August and September. It is about the size of *pellionella*. The forewings are, however, uniformly pale ocherous, without markings or spots. Its larva feeds on a large variety of animal substances—woolens, hair, feathers, furs, and in England it has even been observed to feed on cobwebs in the corners of rooms,

[1] *Tineola biselliella* Hummel.

and in confinement has been successfully reared on this rather dainty food substance. The report that it feeds on dried plants in herbaria is rather open to question, as its other recorded food materials are all of animal origin.

Frequently this species is a very troublesome pest in museums, particularly in collections of the larger moths. Prof. F. M. Webster, of the Bureau of Entomology, once had some of his large moths badly riddled by its larvæ, and Hagen also records it as feeding on insect collections. Riley reared it in conjunction with the Angoumois grain moth[1] from grain, it being apparent that its larvæ had subsisted on dead specimens of the grain moth. It is very likely to attack large Lepidoptera on the spreading board, and has, in fact, been carried through several generations on dried specimens of moths.

Its general animal-feeding habit is further indicated by the interesting case reported by Dr. J. C. Merrill, U. S. A., who submitted a sample can of beef meal which had been rejected as "weevilly." The damage proved to be due to the larvæ of *Tineola biselliella*, and goes to substantiate the theory already advanced that clothes moths were scavengers in their earliest association with man.

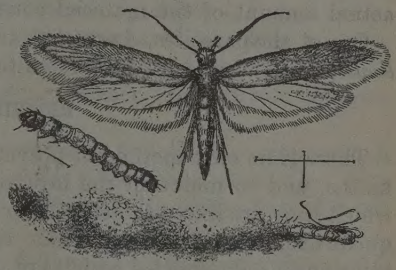

FIG. 2.—*Tineola biselliella:* Moth, larva, cocoon, and empty pupa skin. Enlarged. (From Riley.)

The larva of this moth constructs no case, but spins a silky, or more properly cobwebby, path wherever it goes. When full grown it builds a cocoon of silk, intermixed with bits of wool, resembling somewhat the case of *pellionella*, but more irregular in outline. Within this it undergoes its transformation to the chrysalis, and the moth in emerging leaves its pupal shell projecting out of the cocoon as with the preceding species.

THE TAPESTRY MOTH.

The tapestry moth[2] (fig. 3) is rare in the United States. It is much larger than either of the other two species, measuring three-fourths inch in expansion of wings, and is more striking in coloration. The head is white, the basal third of the forewings black, with the exterior two-thirds of a creamy white, more or less obscured on the middle with gray; the hind wings are pale gray.

This moth normally affects rather coarser and heavier cloths than the smaller species and is more apt to occur in carpets, horse blankets, and

[1] *Sitotroga cerealella* Oliv. [2] *Trichophaga tapetzella* L.

tapestries than in the finer and thinner woolen fabrics. It also affects felting, furs, and skins, and is a common source of damage to the woolen upholstering of carriages, being rather more likely to occur in carriage houses and barns than in dwelling houses. Its larva enters directly into the material which it infests, constructing burrows or galleries, which it lines more or less completely with silk. Within these galleries it is protected and concealed during its larval life, and later undergoes its transformations without other protection than that afforded by the gallery. The damage is due as much or more to its burrowing than to the actual amount of the material consumed for food.

FIG. 3.—*Trichophaga tapetzella:* Adult moth. Enlarged. (From Riley.)

One of the parasites, *Apanteles carpatus* Say, reared from *Tinea pellionella*, has also been reared from the tapestry moth at St. Louis, Mo.

REMEDIES.

There is no easy method of preventing the damage done by clothes moths, and to maintain the integrity of woolens or other materials which they are likely to attack demands constant vigilance, with frequent inspection and treatment. In general, they are likely to affect injuriously only articles which are put away and left undisturbed for some little time. Articles in daily or weekly use, and apartments frequently aired and swept, or used as living rooms, are not apt to be seriously affected. Carpets under these conditions are rarely attacked, except sometimes around the borders, where the insects are not so much disturbed by walking and sweeping. Agitation, such as beating, shaking, or brushing, and exposure to air and sunlight, are old remedies and still among the best at command. Various repellents, such as tobacco, camphor, naphthaline cones or balls, and cedar chips or sprigs, have a certain value if the garments are not already stocked with eggs or larvæ. The odors of these repellents are so disagreeable to the parent moths that they are not likely to come to deposit their eggs as long as the odor is strong. As the odor weakens the protection decreases, and if the eggs or larvæ are already present, these odors have no effect on their development; while if the moths are inclosed with the stored material to be protected by these repellents, so that they can not escape, they will of necessity deposit their eggs, and the destructive work of the larvæ will be little, if at all, restricted. After woolens have been given a vigorous and thorough treatment and aired and exposed to sunlight, however, it is of some advantage in packing them away to inclose with them any of the repellents mentioned. Cedar chests and wardrobes are of value in proportion to the

freedom of the material from infestation when stored away; but, as the odor of the wood is largely lost with age, in the course of a few years the protection greatly decreases. Furs and such garments may also be stored in boxes or trunks which have been lined with heavy tar paper used in buildings. New papering should be given to such receptacles every year or two. Similarly, the tarred paper moth bags obtainable at dry-goods houses are of some value; always, however, the materials should first be subjected to the treatment outlined above.

To protect carpets, clothes, and cloth-covered furniture, furs, etc., these should be thoroughly beaten, shaken, brushed, and exposed as long as practicable to the sunlight in early spring, either in April, May, or June, depending on the latitude. The brushing of garments is a very important consideration, to remove the eggs or young larvæ which might escape notice. Such material can then be hung away in clothes closets which have been thoroughly cleaned, and, if necessary, sprayed with benzine about the cracks of the floor and the baseboards. If no other protection be given, the garments should be examined at least once a month during summer, brushed, and, if necessary, exposed to the sunlight.

It would be more convenient, however, so to inclose or wrap up such material as to prevent the access of the moths to it, after it has once been thoroughly treated and aired. This can be easily effected in the case of clothing and furs by wrapping tightly in stout paper or inclosing in well-made bags of cotton or linen cloth or strong paper. Dr. L. O. Howard has adopted a plan which is inexpensive, and which he has found eminently satisfactory. For a small sum he secures a number of the large pasteboard boxes, such as tailors use, and in these packs away all winter clothing, gumming a strip of wrapping paper around the edge, so as to seal up the box completely and leave no cracks. These boxes with care will last many years. With thorough preliminary treatment it will not be necessary to use the tar-impregnated paper sacks sold as moth protectors, which may be objectionable on account of the odor.

In the case of furniture or carriages, covered or lined with woolen cloth, stored or left unused for the summer, examination and thorough brushing should be given at least monthly. Spraying monthly with benzine or naphtha or sponging with dilute corrosive sublimate has been recommended, but due regard should be given to the inflammability of these sprays and to the poisonous nature of the corrosive sublimate.

The method of protection adopted by one of the leading furriers of Washington, D. C., who also has a large business and experience in storing costly furs, etc., is practically the course already outlined. Furs when received are first most thoroughly and vigorously beaten with small sticks, to dislodge all loosened hair and the larvæ or moths.

They are then gone over carefully with a steel comb and packed away in large boxes lined with heavy tar roofing paper, or in closets similarly lined with this paper. An examination is made every two to four weeks, and, if necessary at any time, any garment requiring it is rebeaten and combed. During many years of experience in this climate, which is especially favorable to moth damage, this merchant has prevented any serious injury from moths.

COLD STORAGE.

The best method of protection, and the one now commonly adopted by dealers in carpets, furs, etc., is cold storage. In all large towns anyone can avail himself of this means by patronizing storage companies, and safety will be guaranteed.

The most economical degree of cold to be used as a protection from clothes moths and allied insects destructive to woolens and furs has been definitely determined by the careful experiments carried out at the instance of Doctor Howard by Dr. Albert M. Read, manager of a large storage warehouse company in Washington, D. C. These experiments demonstrated that a temperature maintained at 40° F. renders the larval or other stages of these insects dormant and is thoroughly effective. The larvæ, however, are able to stand a steady temperature as low as 18° F. without apparently experiencing any ill results. Doctor Read's experiments have extended over two years, and his later results as reported by Doctor Howard are very interesting. They have demonstrated that while a temperature kept uniformly at 18° F. will not destroy the larvæ of *Tineola biselliella* or of the black carpet beetle,[1] "an alternation of a low temperature with a comparatively high one invariably results in the death of the larvæ of these two insects. For example, if larvæ of either which have been kept at a temperature of 18° F. are removed to a temperature of 40° to 50° F., they will become slightly active and, when returned to the lower temperature and kept there for a little time, will not revive upon a retransfer to the warmer temperature."

It is recommended, therefore, that storage companies submit goods to two or three changes of temperature as noted before placing them permanently in an apartment kept at a temperature of from 40° to 42° F. The maintenance of a temperature lower than the last indicated is needless and a wasteful expense. Where the cost of cold storage is not an item to be seriously considered, the adoption of this method for protection of goods during the hot months is strongly recommended.

[1] *Attagenus piceus* Oliv.

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Contribution from the Bureau of Entomology, L. O. Howard, Chief.

THE APPLE-TREE TENT CATERPILLAR.[1]

By A. L. QUAINTANCE,

In Charge of Deciduous Fruit Insect Investigations.

INTRODUCTION.

The conspicuous, unsightly nests or tents of the apple-tree tent caterpillar (fig. 1) are familiar objects in the spring in trees along roadways, streams, and fences, in neglected orchards, and elsewhere.

The gregarious caterpillars construct the tents for their protection, and these, at first small, are gradually enlarged as the larvæ grow, often to a foot or more in height and diameter, the size varying with the number of individuals in the colony. The caterpillars feed upon the foliage of the trees, stripping the leaves from the limbs adjacent to the nest, and if there be several colonies in a tree, as is frequently the case during periods of abundance, the foliage may be quite destroyed, leaving the branches as bare as in midwinter (fig. 2).

DISTRIBUTION AND FOOD PLANTS.

The tent caterpillar is a native American species occurring quite generally in the United States from Canada south to Florida and westward about to the Rocky Mountains. From the Rockies to the Sierras, according to Dyar, the species is replaced by another of the same genus,[2] which ranges from Canada to Mexico, and this latter form in the Pacific Northwest is replaced by still another species.[3]

The tent caterpillar has been a troublesome pest from the earliest times. As stated by Fitch, its injuries in Massachusetts in the years 1646 and 1649 led the early settlers to term these "caterpillar years." At rather long and irregular intervals the caterpillars have been excessively abundant in different parts of their range, but more

[1] *Malacosoma americana* Fab. [2] *Malacosoma fragilis* Stretch. [3] *Malacosoma pluvialis* Dyar.

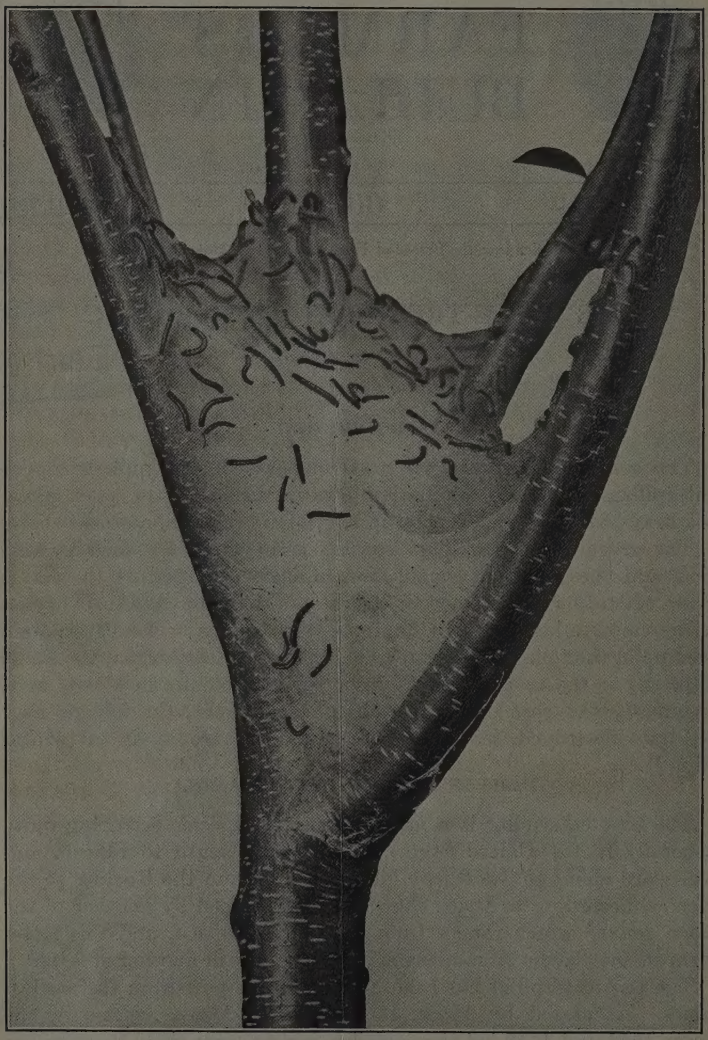

FIG. 1.—Nest and larvæ of apple-tree tent caterpillar in crotch of wild cherry tree. (Original.)

particularly in the New England States. This species was among the first to receive attention by the early American entomologists, and the principal features in its life and habits have been known for many years. Throughout its extended distribution the insect is likely to be abundant each year in one or more localities and often over a considerable territory. Scattered nests are to be found usually during any spring, although in some seasons these are but little in evidence.

FIG. 2.—Nests of apple-tree tent caterpillar in wild cherry tree which the larvæ have defoliated. (Original.)

The favorite food of the tent caterpillar is the wild cherry, and this is probably its native food plant. Next to the wild cherry the apple is apparently preferred. In the absence of its favorite food, or under special conditions, it attacks many other plants, as plum, peach, thorn, pear, rose, and other members of this group, as also beech, witch-hazel, elm, maple, and various species of willows, oaks, and poplars. During periods of unusual abundance trees are more or less completely defoliated, and at a time when they most need the leaves for their growth or for the development of the fruit, and they are materially weakened, though rarely killed.

DESCRIPTION AND LIFE HISTORY.

THE EGG.

Eggs are deposited in masses or belts encircling the smaller twigs, as shown in figure 3. Different egg masses may vary from one-half to three-fourths of an inch in length and contain from 150 to 250 eggs. The average number of eggs in several egg masses counted by Prof. V. H. Lowe on peach and apple was about 223 each. Each egg belt is deposited by an individual female and ordinarily represents the entire number which she will deposit. Eggs are placed on end, cemented closely together, the whole oval-shaped mass being finally covered with a layer of light-brown frothy glue, which soon becomes tough, brittle, and glistening.

FIG. 3.—Egg masses of apple-tree tent caterpillar. Slightly enlarged. (Original.)

Eggs are deposited by the moths by early midsummer, or earlier in the South, the embryonic larvæ developing so that by fall they are practically full grown, although remaining within the egg until the following spring. With the coming of a warm spell the larvæ escape by gnawing through their eggshells, often before there is foliage out for food, and under these circumstances they may feed upon the glutinous covering of the egg mass.

THE LARVA.

In the presence of food the larvæ begin the formation of their nest in about two days from hatching, usually selecting the crotch formed by two limbs and ordinarily one that is not far from the egg mass. The caterpillars are sociable, those from one egg mass inhabiting one nest and feeding together upon the adjacent leaves. If two egg masses happen to be deposited close together, as on the same or

adjacent twigs, the resulting caterpillars may unite in one nest. Wherever they go each larva spins a thread of silk, the young individuals hanging suspended from a silken thread when they drop, as do the cankerworms and many other larvæ. The nests, at first small and affording but little shelter, are gradually enlarged as the caterpillars grow and soon furnish ample protection. Upon close examination the nests of this species will be found to be made up of layers of silk, with room for the larvæ between the layers. According to Fitch these layers are the result of the caterpillars' habit of lying on the outside of the nest during bright weather, the few restless individuals crawling back and forth over the resting mass, spinning silk

FIG. 4.—Full grown apple-tree tent caterpillar. About twice natural size. (Original.)

as they go, soon forming a new layer. During rainy and cloudy weather the larvæ remain mostly within the nest, but when the weather is favorable they feed at regular intervals; according to Fitch, in the morning, in the afternoon, and again during the night. Upon becoming nearly full grown the larvæ wander singly away from the nest, feeding upon such plants as come to hand. This wandering habit preparatory to pupation results in the scattering of the pupæ and greatly increases the chances of their escape from destruction from their numerous natural enemies.

When full grown the caterpillars are about 2 inches long, cylindrical, deep black, with a white stripe along the back, and lateral markings, as shown in figure 4. On each side is a row of oval pale-

blue spots, one on the middle of each segment, and on the anterior side of each is a broader, deep velvety black spot. The body is sparsely clothed with fine, soft, yellowish hairs of varying length, thickest perhaps toward the anterior end, where they project forward over the black-colored head. In about six weeks from hatching the larvæ become full grown and wander away from the nest, as stated, in search of suitable places for pupation.

THE COCOON.

The larvæ select for pupation any convenient, more or less secluded place, as under loose bark, in grass or brush under trees, along fences, etc. If close to outbuildings the larvæ often make their cocoons in

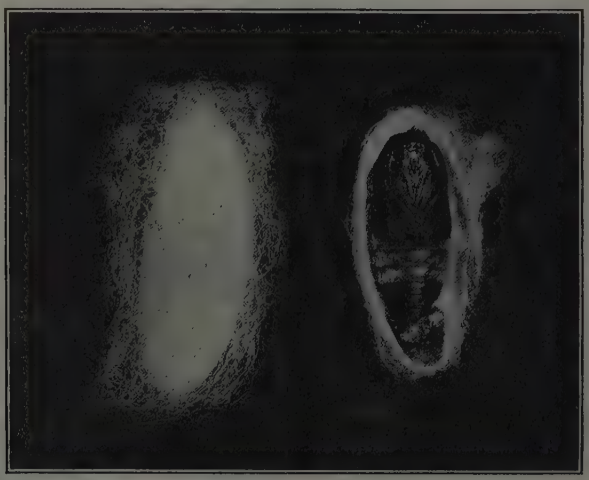

FIG. 5.—Cocoon and pupa of apple-tree tent caterpillar. About twice natural size. (Original.)

the angles along the sides, in window casings, etc. The cocoon, shown in figure 5, at the left, is oval in shape, about 1 inch long, and composed exteriorly of coarse, loose, whitish threads of silk surrounding the tougher parchmentlike lining. The silk of the cocoon is intermixed with a yellow powdery substance, which readily comes off when disturbed. Cocoons are made more or less singly, although in suitable shelter near the nest several may be found spun together, the larvæ taking advantage of the same protection. Cocoons are frequently found within the nest, although these will usually prove to be parasitized.

THE PUPA.

Within the cocoon the larva changes to a short, oval, brownish pupa, as shown in figure 5, at the right. This stage lasts about three weeks, the time varying somewhat; then the moth appears.

THE ADULT.

Both sexes of the tent-caterpillar moth are shown in figure 6, the female to the right. These are dull reddish-brown, stout-bodied moths, with a wing expanse in the females of about 1.5 to 2 inches, and in the males of from 1.2 to 1.3 inches. Obliquely across the forewings of each sex are two nearly parallel whitish lines, as shown in the illustration. Soon after emergence the sexes mate, and eggs are deposited on limbs and twigs. There is only one generation each year, the insects existing in the egg stage throughout the remaining summer and fall and through the winter, the young larvæ coming from the eggs in early spring and forming their nests, or tents, as stated.

FIG. 6.—Moths of apple-tree tent caterpillar; male at the left. Slightly enlarged. (Original.)

NATURAL ENEMIES.

This species is subject to attack by numerous parasitic and predaceous enemies, which undoubtedly exert an important influence in keeping it reduced. Very minute, four-winged flies of the order Hymenoptera deposit their eggs within those of the tent caterpillar moth, the resulting larvæ or grubs finding sufficient food for their growth and development to parent flies. Three egg parasites have been recorded for this species.[1]

Larvæ and pupæ furnish food for a large number of parasites and hyperparasites. Thus W. F. Fiske [2] records a total of some 24 species of insects which directly or indirectly feed upon the tent caterpillar. Eighteen primary parasites have been recorded from the larva and pupa.[3]

[1] *Telenomus clisiocampae* Riley, *Pteromalus* sp., and *Platygaster* sp.

[2] Tech. Bul. No. 6, N. H. College Agric. Exp. Sta., p. 2 (1903).

[3] *Itoplectis conquisitor* (Say), *Itoplectis annulipes* (Brullé), *Pimplidea pedalis* (Cress.), *Iseropus inquisitoriella* (Dalla Torre), *Limnerium fugitivum* Say, *Ameloctonus clisiocampae* Weed, *Anomalon exile* Prov., *Anomalon anale* Say, *Spilocrytus extrematis* Cress., *Apanteles congregatus* var. *rufocoxalis* Riley, *Apanteles clisiocampae* Ashm., *Rhogas intermedius* Cress., *Hadrobracon hopkinsi* Vier. (mentioned in the reference given above as *Bracon gelechiæ* Ashm., an erroneous determination), *Diglochis omnivorus* Walk., *Miotropis clisiocampae* Ashm., *Theronia melanocephala* Brullé (?)—all Hymenoptera—and the dipteron *Frontina frenchii* Will.

Among predaceous insects are several species of ground beetles which are said to feed upon the larvæ, among them *Calosoma scrutator* Fab. Among the Hemiptera Mr. A. H. Kirkland has observed several species of Podisus[1] and the reduviid, *Diplodus luridus* Stål, attacking the larvæ. According to Prof. Bruner, *Podisus spinosus* Dall. and *Perillus claudus* Say also are enemies of the caterpillar.

While most birds as a rule do not feed on hairy larvæ such as the tent caterpillar, yet several species are known to include this insect in their diet, as the black-billed and yellow-billed cuckoos, the blue-jay, and, according to Mr. E. H. Forbush, the crow, chickadee, Baltimore oriole, red-eyed vireo, chipping sparrow, and yellow warbler. Kirkland states that the common toad feeds greedily on tent caterpillars, he having found in their stomachs the remains of from 15 to 20, and in one instance 37 of these larvæ.

FIG. 7.—Itoplectis in the act of ovipositing on cocoon of apple-tree tent caterpillar. Enlarged. (After Fiske.)

The caterpillars are also subject to destruction by a bacterial disease, especially when they become grown or nearly so, and sick, sluggish individuals may often be observed lying outside at full length on the nest. Larvæ killed by this disease are soft-bodied, the skin easily rupturing and permitting the escape of the liquid, decomposed body contents.

METHODS OF CONTROL.

REMOVAL OF USELESS TREES.

As has been stated, the unsightly nests of the tent caterpillars are especially apt to be found on wild cherry, apple, and other trees growing along roadsides, fences, and elsewhere. In most cases such trees could doubtless be removed without disadvantage, and their removal would greatly reduce the numbers of this pest by lessening their favorite food supply.

COLLECTING THE EGGS.

During the dormant period of trees, when the leaves are off, the egg masses are fairly conspicuous, and with a little practice may be readily found; it is then that the twigs bearing them should be cut off and burned. Trees infested with larvæ during the early part of the year, or those in the immediate vicinity, are perhaps more likely to be chosen by the parent moth for the deposition of her eggs, and such trees at least should be searched if it is not practicable to extend

[1] *Podisus placidus* Uhl., *P. modestus* Dall., and *P. sericeventris* Uhl.

the work to the orchard as a whole. This work may be combined with pruning to good advantage, and a lookout should be kept not only for the eggs of this insect but for the eggs and cocoons of other injurious species which pass the winter on the trees.

Practical illustrations of what may be accomplished in collecting the egg masses of this species have recently been reported by Prof. Myron A. Cobb, of the Central State Normal School at Mount Pleasant, Mich. The tent caterpillar was present in unusual numbers in northwestern Michigan during the season of 1913, and egg masses were consequently very much in evidence the following winter (1913–14). Through circulars issued to the rural schools, the school children were interested in the collection of egg masses, with surprisingly successful results. A special "apple-tree tent-caterpillar week" was designated and other means adopted to carry out effectively the campaign against this insect. The total number of egg masses collected through the work of the school children was variously estimated at from one million to several million. A few specific examples may be cited. In Wexford County 250,000 egg masses were reported to have been collected. At Greilickville, 20,443; Bungham School, Grand Traverse County, 17,940. At Elk Rapids the Business Mens' Association offered prizes for the greatest number of egg masses destroyed. This also was done at Old Mission and 65,784 egg masses were collected, the prize going to Carl Ostlind for 11,044 egg masses taken.

Since each egg mass contains on the average some 250 eggs, the benefits from this work may readily be calculated.

There are great possibilities for the accomplishment of much effective work in the control of this and other insect pests by the enlistment of the services of children in rural schools, and the work is a practical application of science for the benefit of agriculture.

DESTROYING THE CATERPILLARS.

Neglect to search out the egg masses during the winter will result in the appearance of the larvæ about the time the trees are putting forth foliage. The nests, at first small, are soon so increased in size as to attract attention. If the caterpillars are destroyed as soon as the small nests are detected, this will prevent further defoliation of the trees, and the rule should be adopted to destroy them promptly as soon as discovered. In this work either of two practices may be adopted, namely, destruction by hand or with a torch.

When in convenient reach, the nests may be torn out with a brush, with gloved hand, or otherwise, and the larvæ crushed on the ground, care being taken to destroy any caterpillars which may have remained on the tree.

The use of a torch to burn out the nests will often be found convenient, especially when these occur in the higher parts of trees. An asbestos torch, such as is advertised by seedsmen, will be satisfactory, or one may be made simply by tying rags to the end of a pole. The asbestos or rags are saturated with kerosene and lighted and the

caterpillars as far as possible cremated. Some caterpillars, however, are likely to escape, falling from the nest upon the application of the torch. In using the torch great care is necessary that no important injury be done the tree; it should not be used in burning out nests except in the smaller branches and twigs, the killing of which would be of no special importance. Nests in the larger limbs should be destroyed by hand, as the use of the torch may kill the bark, resulting in permanent injury.

SPRAYING WITH ARSENICALS.

Tent caterpillars are readily destroyed by arsenicals sprayed on foliage of trees infested by them. Dr. H. T. Fernald's careful experiments and those of Prof. Lowe in determining the amount of poison necessary to kill the caterpillars show that the latter are very sensitive and are killed in from two to three days by the use of Paris green at the rate of 1 pound to 300 or 400 gallons of water.

Orchards or trees sprayed with arsenicals in the spring for the codling moth, cankerworms, or similar insects will be kept practically free from tent caterpillars, and this species rarely requires attention at the hands of the up-to-date commercial fruit grower. It will be troublesome in the scattered trees around the home or in the small orchard which is not regularly sprayed. On such trees the nests will likely be in evidence every spring, and during occasional years the caterpillars may be excessively abundant, completely defoliating the trees.

Even in the small home orchard of a dozen or more trees it will be found highly profitable to adopt a system of spraying which will control not only tent caterpillars but such serious pests as the codling moth, cankerworms, and various bud and leaf feeding insects, and will greatly reduce injury from the curculio.

Any of the arsenical insecticides may be used, as Paris green, Scheele's green, arsenate of lead, etc. The first two are used at the rate of 1 pound to 150 or 200 gallons of water, and the last at the rate of 2 pounds to 50 gallons of water, the milk of lime obtained by slaking 2 or 3 pounds of stone lime being added to neutralize any caustic effect of the arsenical on the foliage. Preferably, however, the poisons should be used in dilute lime-sulphur wash or Bordeaux mixture, thus effecting a combination treatment for insects and fungous diseases. On stone fruits, such as cherry, peach, and plum, arsenicals are likely to cause injury to foliage and must be used with caution. On such trees the arsenate of lead is preferable to the arsenicals, as it is less injurious to foliage, and on all trees sticks much better. In spraying for the tent caterpillar only, applications should be made while the caterpillars are yet small, as these succumb more quickly to poisons than those more nearly full grown, and prompt treatment stops further defoliation of the trees.

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